

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:-

1. A selected stably reproducing *Papaver somniferum* having an expressed, stable heritable trait of a higher (S)-reticuline than morphine content.
- 5 2. A stably reproducing *Papaver somniferum* according to claim 1, which upon the harvesting of the poppy capsules will yield a poppy straw having a higher (S)-reticuline than morphine content.
3. A stably reproducing *Papaver somniferum* according to claim 1, which upon the collection and drying of the latex from immature poppy capsules will yield an  
10 opium having a higher (S)-reticuline to morphine content.
4. A stably reproducing *Papaver somniferum* according to ~~any one of claims 1 to 3~~ in which the production or activity of (S)-reticuline oxidase is inhibited.
5. A stably reproducing *Papaver somniferum* according to ~~any one of claims 1 to 3~~ in which the production or activity of dehydroreticuline reductase is inhibited.
- 15 6. A stably reproducing *Papaver somniferum* according to ~~any one of claims 1 to 3~~ in which the production or activity of berberine bridge enzyme (BBE) is inhibited.
7. A stably reproducing *Papaver somniferum* according to ~~any one of claims 1 to 3~~ in which the production or activity of two or more enzymes selected from the  
20 group comprising: (S)-reticuline oxidase, dehydroreticuline reductase or berberine bridge enzyme (BBE) are inhibited.
8. A stably reproducing *Papaver somniferum* according to ~~any one of claims 1 to 7~~,<sup>2</sup>  
which will yield a poppy straw having an (S)-reticuline content greater than

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1.0%, ~~and more preferably greater than 2.5%~~ upon harvesting of the poppy capsules.

9. A stably reproducing *Papaver somniferum* according to ~~any one of claims 1 to 7,~~<sup>3</sup> which will yield an opium having an (S)-reticuline content greater than 10%, ~~and more preferably greater than 20%~~ upon collection and drying of the latex from immature poppy capsules.
10. A stably reproducing *Papaver somniferum* according to ~~any one of claims 1 to 9~~ which upon the harvesting of the poppy capsules will yield a poppy straw, an opium or an extracted alkaloid mixture having an (S)-reticuline to phenanthrene alkaloid ratio of about 100% or greater by weight.
11. A stably reproducing *Papaver somniferum* according to ~~any one of claims 1 to 9~~ which upon the harvesting of the poppy capsules will yield a poppy straw, an opium or an extracted alkaloid mixture having an (S)-reticuline to phenanthrene alkaloid ratio of about 200% or greater by weight.
12. A stably reproducing *Papaver somniferum* according to ~~any one of claims 1 to 9~~ which upon the harvesting of the poppy capsules will yield a poppy straw, an opium or an extracted alkaloid mixture having an (S)-reticuline to phenanthrene alkaloid ratio of about 1250% or greater by weight.
13. A stably reproducing *Papaver somniferum* according to ~~any one of claims 1 to 9~~ which upon the harvesting of the poppy capsules will yield a poppy straw, an opium or an extracted alkaloid mixture having an (S)-reticuline to phenanthrene alkaloid ratio of up to about 2500% by weight.

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14. A stably reproducing *Papaver somniferum* according to ~~any one of claims 1 to 9~~ which upon the harvesting of the poppy capsules will yield a poppy straw, an opium or an extracted alkaloid mixture having substantially no phenanthrene alkaloid content.
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- 5 15. A seed yielding a stably reproducing *Papaver somniferum* according to ~~any one~~  
<sup>1</sup>  
~~of the preceding claims.~~
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16. Poppy straw of a stably reproducing *Papaver somniferum* ~~according to any one of~~  
~~claims 1 to 14~~, the threshed straw having a higher (S)-reticuline than morphine content.
- 10 17. Poppy straw according to claim 16, wherein the (S)-reticuline to phenanthrene alkaloid ratio is 100% or greater by weight.
18. Poppy straw according to claim 16, where in the (S)-reticuline to phenanthrene alkaloid ratio is 200% or greater by weight.
- 15 19. Poppy straw according to claim 16, wherein the (S)-reticuline to phenanthrene alkaloid ratio is 1250% or greater by weight.
20. Poppy straw according to claim 16, wherein the (S)-reticuline to phenanthrene alkaloid ratio is up to 2500% by weight.
21. Poppy straw according to claim 16, having substantially no phenanthrene alkaloid content.
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- 20 22. Poppy straw according to ~~any one of claims 16 to 21~~, having an (S)-reticuline content greater than 1.0%, and more preferably greater than 2.0%.
23. Poppy straw according to claim 22, having an (S)-reticuline content of about 3-4%.

24. Opium of a stably reproducing *Papaver somniferum* ~~according to any one of claims 1 to 14~~, the opium having a higher (S)-reticuline than morphine content.
25. Opium according to claim 24, wherein the opium has an (S)-reticuline to phenanthrene alkaloid ratio of 100% or greater by weight.
- 5 26. Opium according to claim 24, wherein the opium has an (S)-reticuline to phenanthrene alkaloid ratio of 200% or greater by weight.
27. Opium according to claim 24, wherein the opium has an (S)-reticuline to phenanthrene alkaloid ratio of 1250% or greater by weight.
28. Opium according to claim 24, wherein the opium has an (S)-reticuline to phenanthrene alkaloid ratio of up to about 2500% by weight.
- 10 29. Opium according to claim 24, having substantially no phenanthrene alkaloid content.
30. Opium according to ~~any one of claims 24 to 29~~, having an (S)-reticuline content greater than 10%, ~~and more preferably greater than 20%.~~
- 15 31. Extracted alkaloid mixture of a stably reproducing *Papaver somniferum* ~~according to any one of claims 1 to 14~~, the extracted alkaloid mixture having a higher (S)-reticuline than morphine content.
32. Extracted alkaloid mixture according to claim 31, having an (S)-reticuline to phenanthrene alkaloid ratio of 100% or greater by weight.
- 20 33. Extracted alkaloid mixture according to claim 31, have an (S)-reticuline to phenanthrene alkaloid ratio of 200% or greater by weight.
34. Extracted alkaloid mixture according to claim 31, having an (S)-reticuline to phenanthrene alkaloid ratio of 1250% or greater by weight.

35. Extracted alkaloid mixture according to claim 31, having an (S)-reticuline to phenanthrene alkaloid ratio of 2500% or greater by weight.
36. Extracted alkaloid mixture according to claim 31, having substantially no phenanthrene alkaloid content.
- 5 37. Extracted alkaloid mixture according to ~~any one of claims~~ claim 31 to 36, having an (S)-reticuline content greater than 30%, ~~and more preferably greater than 60%.~~
38. A stand of a stably reproducing *Papaver somniferum* ~~according to any one of claims 1 to 14.~~
39. (S)-reticuline when obtained from a stably reproducing *Papaver somniferum*  
10 ~~claim 1~~ ~~according to any one of claims 1 to 14, a poppy straw according to any one of claims 16 to 23, an opium according to any one of claims 24 to 30 or extracted alkaloid mixture according to any one of claims 31 to 27.~~
40. A method from the production of (S)-reticuline which comprises the steps of:
- 15 a) harvesting poppy capsules of a selected stably reproducing *Papaver somniferum* having an expressed, stable heritable trait of a higher (S)-reticuline than morphine content, to produce a straw having a higher (S)-reticuline than morphine content; and
- b) chemically extracting the (S)-reticuline from the straw.
41. A method for the production of (S)-reticuline which comprises the steps of:
- 20 a) collecting and drying the latex of the immature poppy capsules of a selected stably reproducing *Papaver somniferum* having an expressed, stable heritable trait of a higher (S)-reticuline than morphine content, to produce opium that has a higher (S)-reticuline than morphine content; and

b) chemically extracting the (S)-reticuline from the opium.

42. A method according to claim 40, wherein the stably reproducing *Papaver somniferum* yields a poppy straw having an (S)-reticuline content greater than 1.0%, and more preferably greater than 2.0%.

5 43. A method according to claim 41, wherein the stably reproducing *Papaver somniferum* yields an opium having an (S)-reticuline content greater than 10%<sub>x</sub> and more preferably greater than 20%.

44. A method according to ~~any one of claims~~ 40 to 43 wherein the stably reproducing *Papaver somniferum* has an (S)-reticuline to phenanthrene alkaloid content of  
10 about 100% or greater by weight.

45. (S)-reticuline when obtained by a method according to any one of claims 40 to 44.

46. A method to improve the (S)-reticuline yield of a stably reproducing *Papaver somniferum*, the method comprises the steps of:

- 15 a) exposing at least one poppy seed of *Papaver somniferum* to a mutagenising agent,
- b) growing the at least one poppy seed to produce a plant bearing a leaf or an immature poppy capsule, optionally through multiple self fertilised generations,
- 20 c) sampling the leaf or poppy capsule for the presence of (S)-reticuline, morphine and codeine, and

- d) repeating steps a) to c) until a poppy plant of *Papaver somniferum* is obtained having a higher (S)-reticuline than morphine content as an expressed, stable heritable trait.
47. A method according to claim 46, wherein steps a) to c) are repeated until the (S)-reticuline content shows no further increase on mutagenesis.
48. A method for the production of (S)-reticuline which comprises the steps of:
- a) harvesting poppy capsules of a selected stably reproducing *Papaver somniferum* having an expressed, stable heritable trait of a higher (S)-reticuline than phenanthrene alkaloid content, to produce a straw having an (S)-reticuline to phenanthrene alkaloid ratio of 100% or greater by weight, and
- b) chemically extracting the (S)-reticuline from the straw.
49. A method for the production of (S)-reticuline which comprises the steps of:
- a) collecting and drying the latex of the immature poppy capsules of a selected stably reproducing *Papaver somniferum* having an expressed, stable heritable trait of a higher (S)-reticuline than phenanthrene alkaloid content, to produce opium having an (S)-reticuline to phenanthrene alkaloid ratio of 100% or greater by weight, and
- b) chemically extracting the (S)-reticuline from the opium.
50. A method to improve the (S)-reticuline yield of a stably reproducing *Papaver somniferum*, the method comprising the steps of:
- a) exposing at least one poppy seed of *Papaver somniferum* to a mutagenising agent,

- b) growing the at least one poppy seed to produce a plant bearing a leaf or an immature poppy capsule, optionally through multiple self fertilised generations,
- c) sampling the leaf or poppy capsule for the presence of (S)-reticuline, morphine and codeine, and
- d) repeating steps a) to c) until a poppy plant of *Papaver somniferum* is obtained having an (S)-reticuline to phenanthrene alkaloid ratio of 100% or greater by weight as an expressed, stable heritable trait.

51. Method for purifying reticuline from an aqueous extract of poppy straw comprising the following steps:

- (i) mixing said extract with toluene at near neutral pH and separating the aqueous and the non-aqueous phases,
- (ii) mixing the aqueous phase from step (i) with toluene at pH of about 9.0 to about 9.4 and separating the aqueous and the non-aqueous phases,
- (iii) extracting reticuline from the non-aqueous phase by caustic extraction.

52. A method according to claim 51, wherein step (i) is repeated before proceeding to step (ii).

53. A method according to ~~claim 51 to~~ claim 52, wherein step (ii) is repeated before proceeding to step (iii).

54. A method according to ~~any one of claims 51 to 53~~, wherein pH in step (i) is about 6.8.

55. A method according to ~~any one of claims 51 to 54~~, wherein pH in step (ii) is about 9.3.



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56. A method according to ~~any one of claims 51 to 55~~, further comprising
- (iv) mixing the caustic extract of step (iii) with toluene at pH of about 8.5 to about 9.5 and separating the aqueous and the non-aqueous phases,
- (v) mixing the non-aqueous phase from (iv) with water at acidic pH, and
- 5 separating the aqueous and the non-aqueous phases,
- (vi) adding alkali to aqueous phase at ambient temperature, ageing for a time sufficient to induce formation of a precipitate and collecting precipitate containing reticuline.
57. A method according to ~~claim 56~~, wherein steps (iv) and/or (v) are repeated.
- 10 58. A method according to claim 56 ~~or claim 57~~, wherein pH in step (iv) is about 9.3.
59. A method according to ~~any one of claims 56 to 58~~, wherein pH in step (v) is about 4.5.
60. A method according to ~~any one of claims 56 to 59~~, wherein alkali is added to achieve a pH of about 9.3.
- 15 61. (S)-reticuline obtained by a method according to ~~any one of claims 51 to 60~~.
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